- Lecture Queues

  Data Structures & Algorithms

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Queues

- Queue is a data structure that can be used to store data which can later be retrieved in the first in first out (FIFO) order.
- Queue is an ordered-list in which all the insertions and deletions are made at two different ends to maintain the FIFO order.
- The operations defined on a Queue are:
    1. Add - Store onto a Queue
    2. remove - retrieve (delete) from Queue
    3. Is_empty - check if the Queue is empty
    4. Is_Full - check if the Queue is full
- A Queue can be very easily implemented using arrays.
- Queue is implemented by maintaining one pointer to the *front* element in the Queue and another pointer pointing to the *rear* of the Queue.
- Insertions are made at the *rear* and deletions are made from the *front*.

- To insert an element in a queue is called Enqueue.
- To delete an element in a queue is called Dequeue.

Real life example

- Waiting in line
- Keyboard buffer
- Job scheduling (FIFO scheduling)
- An electronic mailbox is a queue
- Billing counter
- Booking movie tickets
- A print queue
- Vehicles on toll-tax bridge
- Luggage checking machine

Queues – Array Implementation

```
class Queue {
public:
    Queue(int s = 10);                          // constructor - default size = 10
    ~Queue() {delete [ ] QueueArray; }          // destructor
    bool add (int);
    bool remove (int &);
    bool isFull()           {return MaxSize == size;}
    bool isEmpty()          {return size == 0; }
private:
    int MaxSize;                                // max Queue size
    int front, rear;
    int *QueueArray;
    int size;                                   // no. of elements in the Queue
};
```

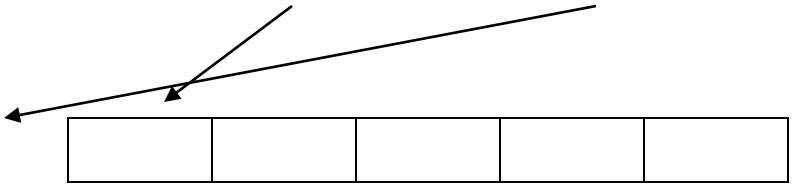
```
Queue::Queue(int s)
{
    if (s <= 0) MaxSize = 10; else MaxSize = s;
    QueueArray = new int[MaxSize];
    size = 0;
    rear = -1;                    // points to the last element
    front = 0;                    // points to first element
}
```

```
bool Queue::Enqueue(int n)
{
    if (! isFull() ) {
            rear++;
            QueueArray[rear] = n;
            size++;
            return true;
    }
    else return false;
}
```

```
bool Queue::Dequeue(int &n)
{
    if (! isEmpty() {
        n = QueueArray[front];
        front++;
        size--;
        return true;
    }
    else return false;
}
```

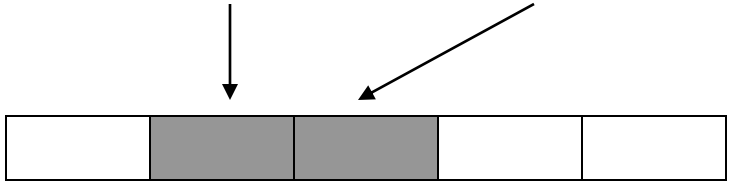
- Assume MaxSize = 5
- Initial condition

  size = 0; front = 0; rear = -1;



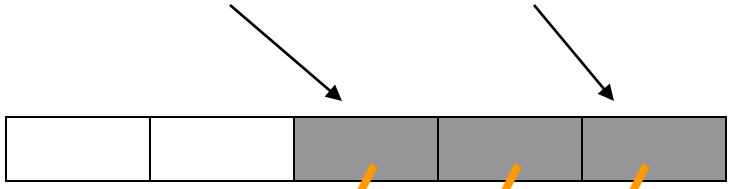
- Add 3, remove 1

  size = 2; front = 1; rear = 2;



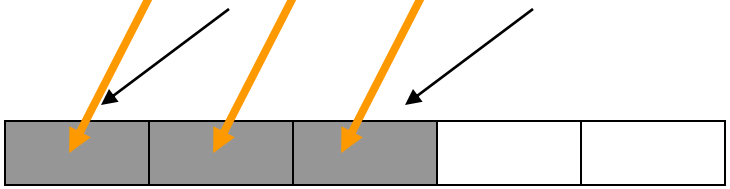
- Add 2 more, remove 1 more

  size = 3; front = 2; rear = 4;



- Question: Is the Queue Full?
- Where to add the next element?
- Push everything back

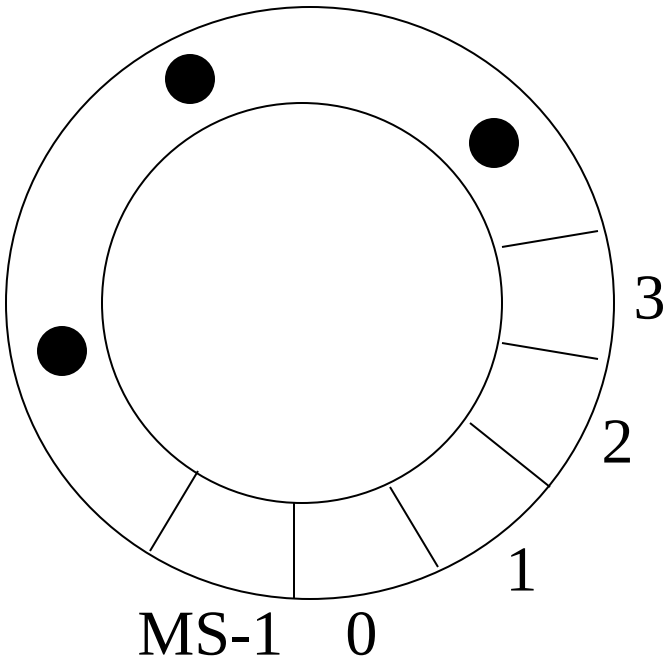
  size = 3; front = 0; rear = 2;



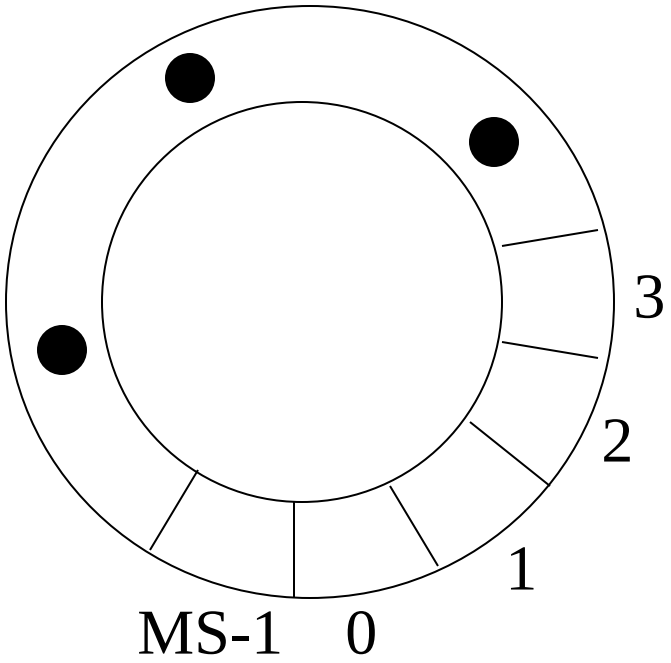
- Cost?
- O (size)

Circular Implementation

```
bool Queue::add(int n)
{
    if (! isFull() ) {
            rear++;
            if (rear == MaxSize)
                    rear = 0;
            QueueArray[rear] = n;
            size++;
            return true;
    }
    else return false;
}
```

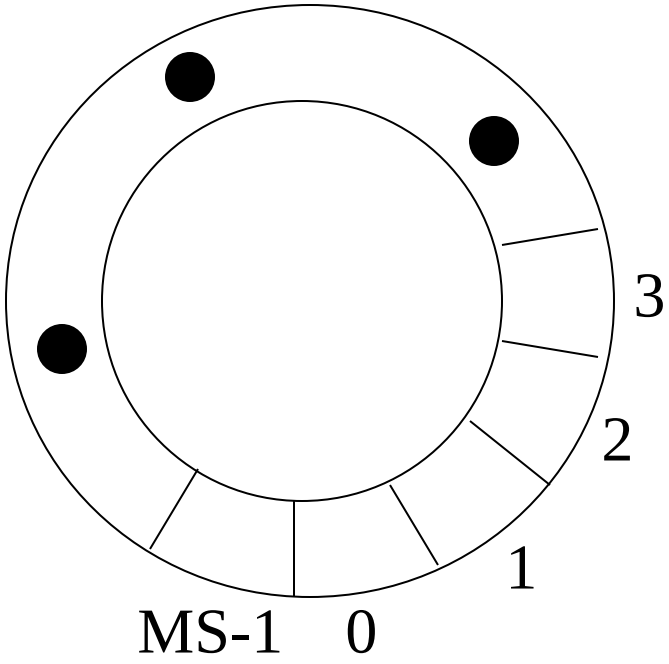


Circular Implementation




```
bool Queue::remove(int &n)
{
    if (! isEmpty() {
        n = QueueArray[front];
        front++;
        if (front == MaxSize)
            front = 0;
        size--;
        return true;
    }
    else return false;
}
```

Circular Implementation



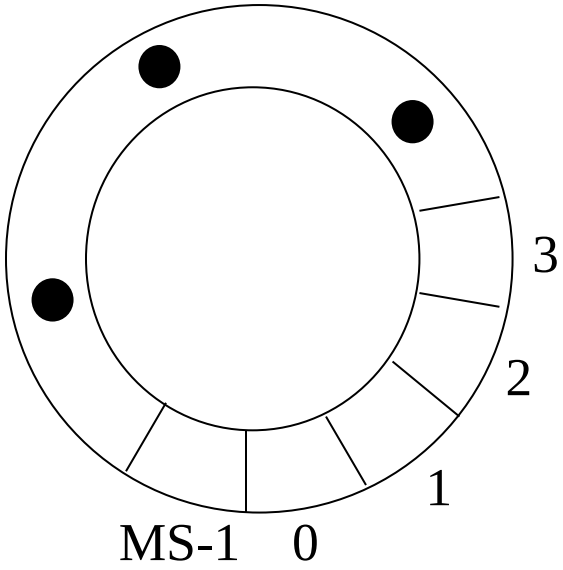
Add → rear = (rear + 1) % MaxSize;

Remove → front = (front + 1) % MaxSize;

```
Queue::Queue(int s)
{
        if (s <= 0) MaxSize = 10; else MaxSize = s;
        QueueArray = new int[MaxSize];
        size = 0;  rear = 0; front = 0;

}
```

```
bool Queue::isFull()        {return size == MaxSize;}
bool Queue::isEmpty()       {return size == 0; }
```




```
bool Queue::add(int n)
{
    if (! isFull() ) {
        QueueArray[rear] = n;
        rear++;
        if (rear == maxSize)
            rear = 0;
        size++;
        return true;
    }
    else return false;
}
```

```
bool Queue::remove(int &n)
{
    if (! isEmpty() ) {
        n = QueueArray[rear];
        front++;
//  If (((Rear+1)%QueueSize)==Front)
    return true;
        if (front == maxSize)
            front = 0;
        size--;
        return true; }
    else return false;
}
```

Reading Materiel

- Introduction to Algorithm CLRS 3e Chapter # 10
- D. S. Malik – Chapter#7